NATIONAL ECONOMIC DEVELOPMENT OFFICE

SECOND REPORT ON EFFICIENCY IN ROAD CONSTRUCTION

A report by a working party of the Economic Development Committee for Civil Engineering

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Preface by the Economic Development Committee for Civil Engineering

The publication of this second report by the working party on costs and productivity in road construction has been authorised by the Economic Development Committee for Civil Engineering. The committee are considering necessary action on this as well as on the earlier report, *Efficiency in Road Construction*, published by HMSO last year. Great tribute is once again due to Mr Lofthouse and the members and secretary of the working party for their hard, thorough and effective work.

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Preface by the Working Party

We were set up in June 1965 as a working party on costs and productivity in road construction, with this remit:
(i) to examine the economic performance of the road construction sector of the civil engineering industry, especially in relation to costs and productivity; to consider ways of improving its efficiency and performance;
(ii) in particular:
  (a) to examine trends of road construction costs and prices and the reasons for them,
  (b) to consider methods of measuring productivity in road construction, to select the most appropriate and to examine the trends in productivity,
  (c) to consider action to increase productivity and reduce costs;
(iii) to submit reports and recommendations on these matters to the Economic Development Committee for the Civil Engineering Industry as appropriate; and to draw the attention of the committee to the possible relevance of our work to other sectors.
We submitted our first report to the EDC in April 1966, and it was published in June under the title *Efficiency in Road Construction.* Since then we have continued our enquiries and we have now completed them. Accordingly we now submit a second and supplementary report.

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5 January 1967

1 Introduction

The scope of this report

1.1 We submitted in April to the Economic Development Committee for Civil Engineering a first report on efficiency in road construction. It was avowedly an interim report: we had not consulted outside our own membership in preparing it, and we had not followed some lines of inquiry to the end. All the same, we considered then that we could frame conclusions and recommendations on many aspects of our subject, and that we should submit these results while the examination of other aspects was still incomplete.

1.2 In order to complete our work, we went on to study manpower questions, and to examine more closely the findings and implications of the cost study we had commissioned from Gardiner and Theobald, chartered quantity surveyors. We also extended our consultations: in particular, we wrote to the local authorities' associations, the professional institutions, the trade federations and other groups interested in the road programme, and invited them to let us have their views on efficiency in road construction.

1.3 We can now submit this, our second main report. In the rest of this chapter, we describe how our first report was received, and how the matters discussed in it have developed since. The second chapter deals with the salient ideas and suggestions that our first report prompted. The third and fourth chapters report the views we have formed in completing our study of manpower, and of the measurement of costs, prices and productivity. In the fifth and final chapter, we review our terms of reference and our work as a whole. Throughout this report, we have tried not to recapitulate the views we expressed before, and its contents are inevitably, therefore, somewhat miscellaneous. (Appendix 1 is a comparative table relating passages in the first report to passages in this.) If this report is not to seem scrappy and disjointed, it should be read as a supplement to the earlier one. Like its predecessor, it represents the consensus of opinion among us, and again we sign it as individuals without spelling out such differences as there are among us on a few points.

The reception of our first report

1.4 Our first report was published in June. The Minister of Transport held a press conference to welcome it. We also saw the comments that the national and technical press made on it, and had observations from individual members of the Economic Development Committee. Subsequently, we received twenty submissions from organisations who had been invited both to comment on the conclusions we had reached, and to draw our attention to any aspects of our subject which the report did not adequately cover. The organisations who sent in memoranda are listed in Appendix 2; opposite each one in the list are shown the initials by which we refer to it elsewhere in this report.

1.5 In general, our first report was warmly welcomed; the Minister of Transport felt able to endorse all but one of its conclusions and recommendations, and found the others either acceptable outright, or at least worthy of detailed study. Most of the submissions we received from organisations, most of the comments made in the press and by individuals commended the general aims we stated. Our particular conclusions and recommendations dealt with problems of which there had been, until then, no consensus of accepted opinion and practice within the industry, and therefore, even though various organisations had natural reservations here or there, it was remarkable how widely and generally most of our conclusions and recommendations were supported.

Developments since our first report

1.6 As the main lines of our thinking were thus seen to be reflected throughout the road-construction industry, so they have very quickly become guidelines for new policies and new practices. Even since we reported, many departures have been made which apply the spirit or a substance of our recommendations. A few derive directly from them; many more derive rather from a climate of opinion which we may have helped to condition, but which also conditioned us.

1.7 In these six months, the Minister of Transport has announced proposals for road construction units which are consistent with our aims of greater continuity of work, and a greater concentration of expertise in the design and supervision of major projects on motorways and trunk roads. She has announced cost-saving changes in the cross-section for motorways, which are the first results of the current general review of the specification. The Ministry have commissioned an extensive study of serial contracting and its implications for roadworks. On one contract, the Ministry have sent information about ground conditions to the selected contractors some months before they receive the normal invitations for tender, so that there is time for them to say if they would like more information and for the Ministry to procure it. The Ministry are reviewing the working of the legal and administrative procedures for planning a road, establishing its line and getting entry to the land, to see if the whole process can be accomplished in a shorter time. They are examining the scope for spending more on the acquisition of expensive property, where this outlay will be outweighed by a resultant saving in construction cost. They are studying how conflicts of interest between public-utility undertakings and highway authorities can be resolved better, and whether safeguards can be devised against excessively costly statutory undertakers' works (the comments we had on this problem confirm that it is very serious and wide-spread). The Ministry have intensified their efforts to promote standardisation in bridge design. They are now prepared to use their powers to acquire land for the contractor's use as a working space or an access route, where he has no choice and could be held up to ransom. The Road Research Laboratory has just completed a comparative study of prices for major items in American and British contracts, and has drawn from it some suggestions about aspects of British practice which may need review. New arrangements have been made for general liaison between the Ministry and contractors at national level, and on selected contracts the contractor, the engineer and the Ministry's representative are meeting periodically to draw any cost-saving lessons there may be for future design. The Ministry have established a procedure for regularly publishing more definite information about the schemes in the forward road programme.

1.8 These developments and the subjects of these studies are not, of course, completely uncontentious. We have seen that many people with experience in the industry are sharply aware of the risks and pitfalls in them. However, where possible innovations are being given detailed scrutiny, and where they are being tried out, the only course that we can usefully follow is to wait and see what the results show. Indeed, all sides of the industry will be interested in the results. The Ministry, at least through its officials who are members of our team, will be well aware of the grounds for caution, as well as the strength of feeling and argument in favour of change. Rather than discuss these issues again in this report, we prefer to leave them to be fully evaluated in detailed study, and finally tested in practical trials.

Outstanding questions arising from our first report

1.9 Some of the submissions we received included suggestions which we feel unable to pursue. We were sent full submissions, for example, about the superiority of black-top paving over concrete, and of concrete-paving over black-top. We were given evidence about improvements in productivity in the supply of road stone, and the difficulties facing suppliers of timber for fencing. Our general discussion of standardisation in bridge design prompted suggestions on its scope, and on ways by which it need not detract from the appearance of bridges. We received observations on the temporary traffic signs associated with roadworks. These points we gave only general consideration, to establish that they did not make it necessary for us to alter the views we expressed before, and have commended them for the necessary technical appraisal to the Ministry of Transport. In the same way, we have suggested informally to the Advisory Council on Road Research that the apparatus for getting information about ground conditions needs development, in order that more results can be obtained in a given time.

1.10 In the present circumstances of road construction, two of our suggestions have been found to present difficulties. Our proposal that clients should pay contractors incentives for early completion has met the objection that, if the roads budget is limited, incentive payments only buy roads sooner at the price of buying fewer roads. We recommended the advance appointment of a contractor, so that he can contribute suggestions for design details to suit his own plant and technique, and can be as fully informed as possible about the job before he starts, but no solutions have yet been found to problems over the conditions of contract. Three other suggestions, by contrast, have won universal support: on the need for closer working between the engineer to the contract and the contractor; on the distinction to be drawn between reasonable and irresponsible claims for additional payments; and on pricing of alternative tenders.

1.11 Four recommendations in our first report dealt with problems which are not peculiar to road construction, and the evidence we have received confirms our view of their importance. Because they are not confined to road building, and because they involve government departments other than the Ministry of Transport, we feel they could too easily be lost to sight. We deal with these recommendations in the following paragraphs.

1.12 Many commentators have emphasised the delay and bother that arise in the acquisition of land and property from the absence of universal, compulsory and comprehensive land registration in this country. The extension of compulsory registration has recently been accelerated, but for all that it will not even be introduced in all areas of the country until 1980; as land need only be registered when its ownership changes, the register will not be reasonably complete for many years after that. We are quite convinced that the repetitive task of searching for the owners and others with an interest in property, which is so time consuming and frustrating for road projects must be equally so for almost all other forms of development. We wonder therefore whether the skilled manpower so engaged could not to some extent be diverted to the once and for all task of compiling a basic register, and *we recommend the Lord Chancellor's Department to accelerate compulsory registration.*

1.13 It has been explained to us that whereas the government's district valuers negotiate for land and property required for motorway and trunk road schemes many county councils use their own valuers for schemes on their own roads. However, the government have a rule that where government grant is payable, the settlement which the county valuer reaches must be confirmed by their own district valuer; they aim to see that the statutory compensation code is uniformly applied and interpreted. This duplicates work, particularly in the preparation of plans and schedules. Moreover when district valuers are overloaded with work, land acquisition can be held up for the district valuer's approval. If district valuers had more professional staff delays on this score should not arise. The duplication too would be avoided if the work on classified road schemes were wholly delegated to county valuers where they are available, who are, after all, men of the same profession and also public servants. *Accordingly we recommend the Ministry of Transport to review the rule so as to remove this cause of delay and duplicated effort.*

1.14 The only recommendation in our earlier report which the Minister of Transport felt unable to accept was that the government should be prepared on occasion to pay more than the district valuer's assessment of the market price of a property, as a condition of quick settlement. We did not perhaps make sufficiently clear how limited was the scope we saw for this departure. We have received further evidence that high costs can sometimes be incurred because a comparatively trivial problem of land acquisition cannot be resolved quickly, through the lack of a flexible commercial approach. *We therefore recommend the Ministry of Transport and other government departments to review the possibility of modifying the rules so as to save money in cases of this kind.*

1.15 The system of assessing and certifying interim payments on road contracts seemed to us to need simplification, and we recommended that consideration be given to this. The system used on roadworks accords with the recommendations of the Institution of Civil Engineers which are accepted on all sides of the industry and codify its long-established practice. They apply to all sectors of the industry, and it has become apparent that road construction cannot be treated in isolation in this matter. The institution itself has told us that a rational modification of the methods used would release skilled professional manpower for more fruitful work, and that a simpler approach would lead to prompter payments. Moreover, some simplifications are already practised by some engineers, and they may deserve wider acceptance for use in appropriate cases as alternatives to the more conventional methods. *Accordingly, we recommend the institution to give renewed consideration to the simplification of the system of assessing and certifying interim payments.*

Conclusion

1.16 We must express our appreciation to those organisations and individuals who have responded to our invitation, and have sent in submissions commenting on our first report. Although, in the main, we have not been led to modify our earlier views, these memoranda have made it plain that what we propose is not uniformly easy to apply, and equally that some of the problems we discussed are even more serious than we realised. We are grateful to all those who sent evidence to us, and we hope that in this report we have done justice to it.

2 Contractors, clients and engineers

The structure of the industry

2.1 In our first report, we observed that no firm has yet had a sufficiently continuous flow of road construction work to commit itself to roadwork and to specialise in it, so as to achieve the fullest efficiency and cost reduction. We proposed that the number of firms in the field for the larger schemes should be reduced. We found little dissent from these conclusions in all the widespread comment they attracted, and the Minister of Transport has adopted them as her department's policy.

2.2 Some commentators (CCA, C OF CAS) have expressed fears that there will be more temptation to price-collusion, and more opportunity for it, if the field of competing contractors is reduced. If our proposals were to assist price collusion, this would seriously undermine them, indeed overthrow them. However, the penalties for price collusion are high. Not only is it illegal under the Restrictive Trade Practices Act, and the undertaking which contractors gave to the Restrictive Trade Practices Court, but also, under the system we envisaged, the Ministry could debar from the competition for further contracts any firms which it detected in price collusion. The Ministry, as a large client offering a large number of projects, is in a fair position to get an inkling of price-collusion by close analysis of tenders, and by scrutinising the results of tendering over a period of time.

2.3 Our proposal that the number of invitations to tender should be reduced, so that about four tenders are received, has also prompted cautious doubts (from CCA and CSS) about the effect this may have on competition. Whether or not such doubts are justified must itself remain doubtful until a smaller number of tenderers has been tried. Without restating the reasons we see for reducing the number of tenders, we can observe that if the doubts prove to be justified, clients can readily increase the number again. Thus, having re-examined the changes we proposed in the structure of the industry and in the number of tenders invited for major contracts, we hold that while they would diminish the field of competition, they should not impair the intensity of competition.

2.4 We have received observations on three aspects of the industry's structure which we did not fully examine in the first phase of our work: sub-contracting; functional contracting; and direct labour. Sub-contractors (as ACMA has pointed out) face special difficulties in that the timing of their operations is left too uncertain, and that these operations tend to be so organised by main contractors that they have to be carried out piecemeal and sporadically; both add to the sub-contractors' costs. These difficulties arise, however, from the nature of road construction: work programmes inevitably need continuous modification in civil engineering. In the organisation of a job that involves many interlocking operations, any one operation can be done at minimum cost only if it is given a priority that inevitably adds to the cost of other operations. Overall cost-reduction therefore requires that the main contractor should weigh up and reconcile as best he can the conflicting consequences of different ways of organising individual operations. It was for this reason that we emphasised in our first report the essential role of the main contractor in providing high-quality project management, since sub-contractors' work programmes are bound to be in his hands.

2.5 The second suggestion is that major clients should let out functional contracts – that is, for example, separate contracts for structural work, for earthworks, and for paving, and should themselves retain managerial control over the project as a whole. Under this arrangement, the specialist paving contractor, for example, could enjoy a clearer run and a more definite timing for his operations than he normally has at present, with consequent reductions in his price. As a result, however, the scheme as a whole is likely to take longer, and so to lock up more invested capital, and the client is involved in the responsibilities and the costs of detailed project-management. He will also be drawn in to disputes that can arise from the later contractor's dissatisfaction with the state of the works left by the earlier contractor. At present, functional contracting is used where it has particular and obvious attractions, and *we do not advocate any general extension of it.*

2.6 Direct labour (ICE, IHE, CCA, ACCS, CSS, C OF CAS) it can fairly be claimed, affords local authorities' staffs immediate experience of costs, and of construction methods; it is also argued that direct labour tends to give lower prices than the employment of contractors, though in our opinion, the inevitable difficulties over the logical allocation of overhead costs in any organisation make a true comparison impossible. Whatever the arguments for and against direct labour, however, we think it will be exceptional for a single county to have a sufficiently large and even flow of large-scale projects to reap the benefits of continuity of work and of a continually accumulating experience by which we have set great store. It is not the Ministry's intention that the road construction units it is introducing should employ direct labour forces, and *we do not therefore see much scope for direct labour on the largest road schemes.*

Plant

2.7 We have given further consideration to road construction plant. High-output plant is plentiful, but much of it is imported at high cost to the country's balance of payments. There is conflicting evidence about the suitability of the available plant for British conditions of climate and geography; there is also some doubt whether British plant manufacturers can, without some external aid or stimulus, develop new types that incorporate technological advances as they become practicable. British plant manufacturers have so far produced little specialised equipment – equipment for asphalt laying is perhaps an exception – because the home market is too small, and foreign suppliers are strong. However, the demand for road construction equipment at home and abroad is expanding, and as road construction specifications and design details develop to allow greater mechanisation new types of plant will be required. Thus there are potential markets at home and abroad and *we recommend plant manufacturers and plant users to look together for opportunities to increase the manufacture in this country of specialised road-construction plant.*

2.8 Road construction costs would be reduced if the available plant were used more intensively. As things are, contractors buy enough plant to ensure that they can meet most of their needs from their own resources. In face of this, plant-hire firms have found more of a market for the smaller general-purpose items of plant, than for the largest and most specialised items that carry a bigger risk. It has been suggested to us (by I MUN E) that the Ministry of Transport itself should set up a pool of plant for hire. However, as the Ministry is the road-construction industry's major client, we can foresee special difficulties if it also becomes a major supplier. On the other hand, if road-construction contractors have a greater assurance of operational continuity, they should be able to use their plant more intensively, to match their general-purpose plant holding more closely to their needs, and to justify financially their purchase of the more specialised types. A greater measure of consolidation among plant-hire firms might make it possible and profitable for them to offer the more specialised items and their crews on hire. Insofar, too, as contractors want to hire the operating team with the machine, there may be more opportunities for sub-contractors who should be able to keep their plant employed more constantly than main contractors can. Perhaps some firms who now operate as main contractors will, as the field narrows, become specialist sub-contractors. In short, *we conclude that as the road-construction industry and the plant-hire industry develop, fuller plant utilisation should follow by natural evolution.*

Contractual questions

2.9 The local authorities' associations (CCA, ACCS, and C OF CAS) have proposed that tenderers should be required to submit critical-path networks along with their tenders. The preparation and adoption of a critical-path schedule ensures that the interacting operations of all parties are mapped out, and that every party understands the implications of his programme for each of the others. We agree that this should be done before the appointed contractor starts major operations on site. However, critical-path networks prepared so early as the tender stage will have little validity, because it will seldom be practicable or desirable for each contractor, before any has been appointed, to think through the project in detail, and discuss separately with all the other bodies concerned the precise fitting together of their various operations. *We recommend therefore that the contractor should be required to submit a critical-path network for works of any complexity soon after he is appointed.*

2.10 Suggestions have been made (by the C OF CAS) for other forms of contract. One possibility is cost-plus contracting, but this gives the contractor too little incentive to reduce his costs, and the client too little assurance that he is paying a fair price. We do not commend it therefore. The second suggestion is for target-price contracts. The fixing of a target price for a scheme, with contractor and client sharing in any savings on the target, gives both sides the incentive to reduce costs. However, if factors outside the contractor's control interfere with the work, it is necessary to renegotiate the target-price – a much more troublesome business even than the agreement of variations within a conventional contract. Accordingly, target-price contracts have so far been used only occasionally in the road programme, for work which is free of interference, such as that on the superstructures of major suspension bridges. Although a new form of contract may have to be devised for large road schemes in urban areas, where it may be impossible when the contract is put out to tender to determine exactly what works will be required to divert statutory undertakers' equipment, no experiments have yet been made in this direction to provide a guide-line for future practice. *Our general conclusion, therefore, on new forms of contract is that it is only for target-price contracts that definite advantages can be claimed and for these only in those exceptional cases where unforeseen contingencies are unlikely to arise.*

Road administration

2.11 The road interests (RAC, AA, BRF) have drawn our attention to their view that the road programme would be carried out more efficiently, and would more closely match in scale what the public wants, if it were administered not by government departments, but by a financially independent roads board with its own source of revenue. Having said what we did in our first report on the price the public is paying for public accountability in the administration of the road programme, we were bound to give this view serious consideration, insofar as it bears on efficiency in road construction. In giving it this consideration we found that the setting up of such a roads board raised many other issues which ran wide of our terms of reference, and on which we were not fitted to pronounce. It was not suprising therefore that we felt unable to resolve a common view, and *we make no recommendation on this question.*

2.12 A number of points in the submissions we have received touch on the responsibilities of the engineer to the contract and his staff on the site. In particular, the local authorities' associations have endorsed the suggestion in our first report that the Ministry should delegate more authority to the engineer. The Ministry of Transport, with its experience as a client, its engineering expertise and its research facilities is acknowledged to have a rather special relationship with its appointed engineer; it must moreover answer as a public department for the consequences of the engineer's decisions. Nevertheless the contractor is entitled to expect that the engineer will be allowed to exercise his functions under the contract, and so to supervise the contract that work goes ahead without interruption.

2.13 It is our view that in working out its relationship with the engineers it appoints as its agents, the Ministry should take account not only of the demonstrable costs of occasional mistakes that they might make, but also of the less demonstrable, though no less real costs of duplication, delay and loss of initiative, to which a close central control gives rise. It should recognise too that the amount of discretion which can properly be given varies with the circumstances of the contract, and that close central control over the engineer when he is supervising the execution of a contract pays a greater penalty than an equal degree of central control over his work of design and preparation. The Ministry is setting up road construction units to design and supervise major schemes on motorways and trunk roads, and this gives them a chance to redefine the extent and limit of the engineer's role and to devise and apply new systems of control. At this time particularly therefore, *we recommend the Ministry to recognise the economies to be made through delegated responsibility and flexible administration as well as the safeguards provided by central control.*

3 Manpower

On-site labour

3.1 The quality, deployment and development of the labour force have clearly not given rise to major problems in new road construction. For despite the many obstacles to the most productive use of labour, industrial relations are remarkably good in road construction, as they are in other sectors of civil engineering. Disputes and stoppages are rare, and the Conciliation Board, on which employers and trade unionists meet for the purpose, has always succeeded in providing an agreed basis for the settlement of any dispute that has been referred to it. Apart from that, the Economic Development Committee has a working party on manpower to give the industry's manpower problems special attention, and it has submitted its first report on them. Accordingly we did not study manpower problems closely in the first phase of our work and in the second phase we have aimed to identify and discuss only those manpower problems which have special significance in the road-construction sector.

3.2 Usable statistical information about the road-construction labour force is scanty; indeed, we were able to raise only the broadest estimate of the total number of menemployed on major road improvements and the construction of new roads – between 30,000 and 40,000 – and no details about the categories of labour employed, their deployment, earnings or conditions of work. The solitary statistic we have shows that the road programme occupies a very small proportion of the construction labour force; the absence of other statistical data makes it difficult to measure the importance of particular manpower problems, or to anticipate those that will arise in future. However, as we report in paragraph **4**.15 the Ministry of Transport intend to improve the labour returns that are now made on each contract, *and we recommend them to give the results a wide circulation, in order that the other sides of the industry too can see the relative magnitude and priority of labour problems in road construction.*

3.3 All civil engineering work, by its nature, imposes difficult working conditions. It is arduous and exposed to the weather, and much of it is unsuitable for older workers. Work-places are temporary, so that everyday facilities – canteens, lavatories and changing-rooms – are not easily provided to acceptable standards; indeed convenient welfare facilities are harder to arrange on an extended road site even than on other construction sites. The work is seasonal: the hours are long in the summer, and in winter earnings are low. Much of the work is casual, and as there cannot be a constant amount of major work in any district, the men must be prepared to work far from home. There is, nonetheless, no shortage of recruits to the industry, but it has been difficult to maintain the quality of the labour force. The turnover of men on a project can be high, because incentive-payment schemes give contractors the means of bidding up earnings, often without any corresponding increase in output. These problems, of the conditions of work and the rewards for it, cannot be considered for the road sector of civil engineering construction in isolation, and they are under study in the manpower working party.

3.4 So far as the particular problems of road construction are concerned, it is satisfactory to record that the industry has seen the need for better deployment of labour, and has been adapting itself to it. For example, the trade unions and the contractors have recently agreed a scheme which will enable men who are not fully trained carpenters to receive limited training as shutter-fixers. The need for more and better-trained plant operatives has also been recognized, and the Construction Industry Training Board has this autumn set up a training centre for them. Better supervisors and technicians are still needed. We have drawn this to the attention of the Construction Industry Training Board, to those responsible for the scheme for the training of civil engineering technicians (which is sponsored by the Institution of Civil Engineers, the Institution of Municipal Engineers, the Association of Consulting Engineers and the Federation of Civil Engineering Contractors), and to the Institution of Works and Highway Superintendents. We have given our encouragement to the activities these organisations are sponsoring. So far the emphasis in their courses has been on technical training in the traditional responsibilities of site managers and foremen. However, they appreciate the need for training in modern routines of project management and control, including, for instance, such techniques as critical path scheduling, and both the training board and the joint scheme are extending their activities in this direction.

3.5 There is also scope for a more productive use of labour through the modification of manning-scales. The number of men, or of man-hours, that a given operation takes varies surprisingly from contractor to contractor. Here as elsewhere there is a dearth of systematically collected quantitative information, to attract the attention of management to those operations where there is room for improvement, but we hope that in future the Road Research Laboratory's production studies (to which we refer in paragraph 4.14) will give contractors and trade unions the information that should guide their efforts.

Professional manpower

3.6 We laid emphasis in our first report on the need for more feedback from those engaged on the execution of road projects to those responsible for their design, specification and procurement. It has been pointed out to us (C OF C AS) that in road construction, practitioners are effectively divided into four streams: members of contracting firms, members of firms of consulting engineers, local authority officials, and government officials. Although both firms and public bodies prefer, indeed sometimes require, their young entrants to have had experience on another side of the industry, few people move from one stream to another after the age of thirty. However much a man may want to transfer, and however welcome he would be if he did so, differences in systems of remuneration and particularly in pension-schemes, raise a barrier that is difficult for him to cross; for only the exceptional man can move without suffering an unacceptable financial setback. Without advocating that large numbers of engineers and managers should transfer so rapidly from one side of the industry to another as never to make a full contribution on any side, we consider it unfortunate that few senior men nowadays have personal experience of work on another side of their industry except perhaps many years before and in a junior capacity. This situation is not confined to road construction, or indeed to the civil engineering industry. For all that, it fosters on every side of the industry misunderstandings and misconceptions about the outlooks and needs of the other sides. *We therefore consider that any steps the government, the industry or the professions can take to make possible the movement of middle and senior management would promote efficiency in road construction.*

Limitations on the expansion of the road programme

3.7 It is sometimes asked what limits there are to the size of the road programme. Clearly the main limitation is financial, and because the processes of design and preparation are long, it would not be possible for the country to start within a year or two very much more work on site than is already some way prepared. However, if the government were to decide that in two or three years time the country should embark on a larger road programme than is now planned, we believe that at least the necessary plant and materials could be brought to bear.

3.8 Manpower is sometimes regarded as a limitation. However, the work has so far been spread widely, too widely in fact, so that more men than the present programme requires have had some first-hand experience of large-scale road construction; a great many more have had at least general training and experience in civil engineering techniques. If it were decided that the road programme should be accelerated these men would quickly be able to contribute. In so far as major roadworks use comparatively little labour this does not appear to be a sector to adjust when the demand for labour needs to be changed. Professional engineers and technicians are not plentiful at present, but the Institution of Civil Engineers is already trying to make the profession more attractive, and the suggestions we have made about the distribution of design work imply that here too there are men with experience of roadworks who are at present engaged in other sectors. In general, too, we believe that if programmes are adopted which seem likely to overstretch somewhat the capacity that is foreseen, all sides of the industry will find ways to produce more than they would with a more modestly pitched target. *Accordingly we do not consider that the availability of manpower at any level would be a practical limitation on the acceleration of the road programme to any pace that is likely to be decided upon, provided that the load on the rest of the industry was not also added to, and that the change of pace was not completely unheralded.*

4 Costs, prices and productivity

Introduction

4.1 In our first report, we described the study of road-construction costs which Gardiner and Theobald, chartered quantity surveyors, undertook on our behalf with the collaboration of a number of contractors. Although we were able to draw some provisional conclusions from it, we had not had time to put to them the supplementary questions that occurred to us. We have since done so, and report our findings in the first half of this chapter. In the second half we discuss the scope for further studies of road-building costs and of the quantities of resources used in building roads and of productivity in road construction.

The costs-study: recapitulation

4.2 The results of the Gardiner and Theobald study of costs in a dozen contracts were broken down in three ways: into three periods: the early period covering contracts starting in 1959 or 1960, the middle period, 1961 or 1962, and the latest, 1963 or 1964; into the six phases of road construction: preliminaries, earthworks, drainage, structures, carriageways works, and fencing and sideroad works; and into the three factors: labour, plant and materials. The main results were presented in terms of the cost per square yard of finished carriageway. Gardiner and Theobald made adjustments to these historic costs for changes in the cost of labour, plant and materials, in order to show the trend of real costs over the period of study; they also attempted to make allowances for changes in the proportions that certain phases of construction contributed to the whole cost of each group of contracts, in order to arrive at standardised cost figures for an imaginary but representative road project. Our first report concentrated on the unadjusted historic figures which were the only ones we included in the published report.

4.3 We drew only tentative conclusions in our first report from the cost trends for particular operations and put forward our broad conclusions with a good deal of reserve. We called attention at the time to the great variety of road contracts, arising from differences in terrain and the local availability of materials, in the number and size of structures, and in the type of carriageway construction. We were aware that a sample of some dozen contracts might be too small to be representative of general cost trends over a quinquennium, and that the more detailed the analysis of any sample the greater the effect of random variation within it; this variation will tend to increase the risk that the data do not represent the whole of the field surveyed, and so less reliance can be placed on the results, whether they are averages, proportions or trends. We stated our intention to examine the study more closely, so as to confirm our provisional conclusions and to draw any further conclusions that the data would support. Accordingly after our first report was presented, we enquired into the variance between the contracts in the sample, and checked individual quantitative results against such comparable data as could be found. The general upshot is that the findings we reported require little modification, but that the study will not substantiate further conclusions.

The costs-study; reappraisal

4.4 In order to check the consistency of the data, the sample of contracts was divided into two sub-samples: one of two-lane dual-carriageway schemes and the other of three-lane dual-carriageway schemes. We would expect to find real differences between the costs per square yard of finished carriageway for each of these sub-groups, and we would also expect to find considerable variations in any sample. Nevertheless any general change in costs or productivity in road construction ought to lead to generally similar trends for both sub-groups. We found, in fact, that many of the cost figures showed conflicting movements between one sub-sample and the other, and that when the movements were in the same direction they were of different magnitude. It follows that the data can support no more than broad generalisations. It is in particular unsafe to draw conclusions about the size or timing of changes either in total costs or in the costs of individual phases of construction.

4.5 Our second check was directed to changes in the quantities of earthworks and structures per square yard of finished carriageway which Gardiner and Theobald reported. The Ministry of Transport have since analysed the earthworks requirements in fifty motorway contracts as shown in bills of quantities, and we find that the requirement can sometimes be as low as four cubic yards of earthworks per square yard of carriageway, and sometimes as high as 20 cubic yards, according to the terrain. It also showed that the average figure Gardiner and Theobald found for the early contracts (5.2 cubic yards) was perhaps somewhat low for schemes of the period, and that the average figure for the latest contracts (12 cubic yards) was exceptionally high, and can only be accounted for as an accident of sampling. Their conclusion, that, as a result of changes in the general specification, earthworks quantities rose over the period of the study, is not in dispute; the Ministry have very recently announced changes which will now reduce earthworks requirements by about ten per cent. However, it is plain that within the study-period changes in the specification had less influence than we inferred, and differences in terrain had more.

4.6 Gardiner and Theobald reported a steep rise between the early period and the middle period in the amount of structural work required per square yard of finished carriageway, and no reduction in quantity between the middle period and the latest period. They also reported a corresponding rise in the cost of structures between the early and middle period, but a sharp fall in cost from the middle to the latest period. It has become clear that accidents of sampling have, here too, been a major influence on their findings. Thus, the trends for the amount and cost of structural work within the sample cannot be taken as representative of the trend of structural work in general, and we went too far in our first report in drawing the inference that the cost-consciousness of designers had been transformed within the period of the study.

4.7 Two lessons stand out from this dissection of the costs study. The first is the extreme variability of road-construction costs and the difficulty of measuring trends with a sample of contracts as small as a dozen. The reasons for the differences could only be explored by examination of each contract's characteristics, but this was not possible because the cost data was made available on the strict understanding that individual contracts would not be identified. To make a comparative analysis of the trends of costs would require a much larger sample, and not only would this make the exercise much more costly and timetaking but the number of major contracts placed may not be sufficient at present to provide a sample of unexceptional schemes that would give valid results for a short period of time. Secondly, however, the collection of quantitative data for particular phases in a simple form appropriate to each phase has prompted instructive enquiries into the real nature of the work carried out, and this approach can clearly provide useful leads to the development of more economical designs and specifications. This enquiry was a pioneering effort, and should perhaps be regarded as a pilot enquiry, rather than as a definitive study of road construction costs.

4.8 Although we have found that the survey data would not support any conclusions beyond those which we drew in our first report, the general conclusions we formulated then have not been shown to be false. Some of them depend, however, as much on general knowledge as on the survey data, and the many reservations we attached to our conclusions have clearly been justified.

4.9 The observations we made on the separate phases of road construction need more review. We have already said (in paragraphs 4.5 and 4.6) that the great changes found in the sample for earthworks costs and structure costs were more attributable to vagaries of terrain, and less attributable than we then supposed to differences in the economy of design and specification. So far as the costs of carriageway and drainage works are concerned we need not qualify our earlier conclusions and should only add that we have drawn the attention of the Advisory Council on Road Research to the high cost of drainage. We have not been able to establish why on-site preliminaries should have risen so as to amount to 16 per cent of total on-site costs in the last period. It has been suggested to us that a major factor has been the imposition by the Ministry of more stringent requirements for testing of materials, but the evidence we have had does not support this. We doubt whether it is, in any case, conducive to good management to spread so large a sum as an overhead, without allocation to particular operations; for all its convenience, this practice must blur the contractor's picture of his own cost structure, and hamper his clear thinking about alternative methods of carrying out the job.

The scope for future studies

4.10 Having reviewed the results of our own costs-study we now consider how the quantitative study of costs, and prices, of efficiency and productivity in road construction should be carried forward. The views we put forward are consistent, we believe, with the approach of the Economic Development Committee's construction statistics working party. From what we have already said in this chapter it will be evident that the measurement of average costs in road construction is extremely difficult, because the nature and amount of construction work required varies greatly from one project to another. As a result, too, of this extreme variability, aggregated measurements of costs and (if they are feasible) of productivity will do little to suggest the areas in which improvements in efficiency are to be sought and found. *We do not consider that a large programme of data collection would be justified for this end.*

4.11 Nevertheless, contractors, engineers, and the Ministry ought to have available to them that relevant and representative information in quantitative form that is essentially required if they are to keep a general check on efficiency, and to keep costs under control. In particular, contractors will need to satisfy themselves that given the current specification, their methods of operation are as efficient as they can be. Suppliers and contractors need the information that will enable them to anticipate the problems that are likely to arise from changes in demand, and the government wants to know about the industry's consumption of resources, and the scope for their more productive use, in order to plan the future allocation of resources to roads. Again the Ministry and the engineers it employs will need to know what roads cost if built to the current specification, and how the specification could be developed so as to give an acceptable performance at lower cost.

Production studies

4.12 Contracting firms have a fair general knowledge of the alternative ways of carrying out particular operations, from the general exchange of information in professional associations, from the technical press and through the activities of trade federations; but naturally little is disclosed in these exchanges on the cardinal question of cost. Thus, contractors have no benchmark against which to set the detailed information they have of their own operational performance, and although, in the long run, competition enables those firms which are, on the whole, more efficient to prosper more than those which are, on the whole, less, each firm's results must be an average of operations done more or less well. There can thus be few firms who are not carrying out some operations rather inefficiently, though many firms will, no doubt, be distinctly above average in other operations. From the national point of view, however, the inefficiencies of firms who are successful enough to survive are even more serious than the inefficiency of firms who are unsuccessful enough to fail.

4.13 Road construction, therefore, like other industries, needs a system of exchanging of information to provide individual firms with a yardstick against which to measure their own performance, in order that they can direct their attention to the improvement of those processes in which it is undoubtedly possible to perform more successfully. Inter-firm comparisons are not new in industry in this country, but they have not gone far in road construction. However, since early in 1966, the Road Research Laboratory has embarked on a few studies to compare the way particular operations are carried out on different contracts. Measurements are taken, by work study, of such factors as the number of men in the crew for a given operation, the proportion of down-time to working-time for the same piece of plant on different contracts, or the main causes of delays to production and their effects. The laboratory intend to make the results of these studies available in a form which will safeguard the anonymity of individual firms and contracts, but provide each contractor with an indication of the highest and lowest observed standards of performance, and the average, in order that he can see what scope there is for improving his own performance, and where he can most usefully direct his efforts to that general end.

4.14 The industry's response to the Road Research Laboratory's investigations on these lines has already been encouragingly favourable. There is, of course, no obligation on any firm of contractors to participate and some may, naturally if complacently, feel that their competitors have more to learn from them than they have from the competitors. For all that, *we recommend the Road Research Laboratory to continue, develop and extend these production-studies as quickly as their own resources and the contractors' response permit, and we recommend contractors, in their own and the general interest, to participate fully.*

Information on resources

4.15 We called attention in our first report, to the industry's need for fuller information about future demand, both on the timing and nature of future schemes in the road programme, and about the likely demand for materials for roadworks, in order that material-suppliers can plan and prepare for a sufficient future output. More information is also needed on the categories and amounts of labour and plant employed in road construction, for there are likely to be shortages of some categories of labour in civil engineering unless they are anticipated, and increasing scope for economy through the development of mechanisation. Contractors, those responsible for training, and those with an interest in the development of plant and of the specification need information in order to direct their efforts so as best to anticipate future needs. At present, contractors are required under the standard conditions of contract to make to the resident engineer returns of the number of men employed and the amount of plant on the site. These returns, which are now designed and used only for the purposes of supervision of each individual contract, could serve as a source for comprehensive statistics of employment and on-site plant. The Ministry intends to explore ways of standardising and collating these returns, so that they can serve more general purposes. For materials, no similar return is made. It is in principle possible to estimate the approximate requirement of each material from bills of quantities, and some work on these lines has been done in the past. This approach to the estimation of materials-usage is necessarily approximate, circuitous and laborious, and an alternative would be to collect, directly from contractors, returns of the quantities of selected materials used, as is done in the United States. The Ministry propose to explore further the merits of both methods; it would be their aim to avoid calling for returns from contractors if a satisfactory alternative can be found.

4.16 We are in sympathy with the Ministry's approach to this problem, and with their proposals. We particularly recommend them only to collect data that serves a purpose whose value is commensurate with the effort of data preparation, collection and analysis. Insofar as they wish to add any new requirements, they should be prepared to discard what has proved of little value, or modify what is unnecessarily burdensome. *We recommend them to study further with all sides of the industry the returns already collected for manpower and plant employed on each contract, and to continue their studies of methods of estimating requirements for materials; and then, with the collaboration of the industry, to revise the systems of data collection so that they are as useful and as economical as they can be.*

Future costs-studies

4.17 The Road Research Laboratory's production studies, and the Ministry of Transport's collection of data on the employment of manpower, plant and materials should both give useful leads to those phases of road construction where there is scope for cost reduction and greater efficiency. The day-to-day experience of contractors, engineers and Ministry officials will also provide pointers, and the arrangements which have recently been made for a stronger liaison between the Ministry and contractors, and between the Ministry and county surveyors, and for feedback meetings on each contract, should all help to ensure that day-to-day experience is digested and acted upon. Nevertheless, the ideas that arise from everyday experience will be difficult to test and evaluate, in the absence of data about costs.

4.18 Two means suggest themselves whereby the Ministry can secure relevant cost data, without prejudice to the individual contractor's desire to keep his costs to himself. In the first place, the full-scale trials on new types of plant and of experimental specifications, which are commissioned in collaboration with the Road Research Laboratory, and with the voluntary participation of a chosen contractor, can provide the clearest evidence of the worthwhileness of a few of the most important or most radical innovations. Secondly, we think that the study which we commissioned from Gardiner and Theobald, has demonstrated the usefulness and practicability of a study-procedure, whereby confidential information can be collated and presented for general use. We think that the Ministry will want to adopt this procedure from time to time in future, and that it would be valuable to all who are concerned with the nature and make-up of costs in road construction, especially if future studies are directed to particular phases of the contract rather than to contracts taken as a whole. It would certainly be necessary on another occasion to adopt a larger sample, in order to even out the great range of variation which was apparent in the study we commissioned. Since such studies concern themselves with individual contractors' costs, they must depend on the willing participation of contractors, who may well insist that they are undertaken, as our study was, by an independent agency on a confidential basis. *We recommend the Ministry to commission further cost-studies on these lines, and we recommend contractors to participate in these studies.*

5 Winding-up

Review of our work

5.1 We conclude this report by reviewing the work we have done and our terms of reference. In the first phase of our work, we consciously directed our attention to major trunk road and motorway schemes. It has been suggested to us that we should turn our attention to urban road schemes (C OF CAS). However, although the creation of new urban primary road networks will be increasingly important we think that there is hardly as yet a sufficient corpus of general experience in this country of the problems that arise in urban road projects on the largest scale, still less of possible solutions to them, and their relative merits. We therefore consider that we could do little to formulate useful general conclusions and recommendations on the problems peculiar to urban road construction.

5.2 It has also been suggested that we should study road-construction projects on classified roads, and the smaller projects on trunk roads (IMUNE). We think that the general aims we stated will apply here, as will many of our detailed recommendations. We recognise that some of our recommendations may be less straightforward to apply because responsibility for smaller projects is inevitably more dispersed, and others could perhaps only be applied if local authorities' statutory powers were modified; for instance they may need to be given powers to make advance payments, amounting to the bulk of the compensation price, for land they enter before the final details of the price are settled. However, we do not think it would be particularly useful if we worked out the detailed scope and form in which our recommendations could best be applied to these schemes, because local highway authorities and the Ministry of Transport are in a position to do this without any special external study.

5.3 Maintenance and minor improvement works were, by implication, excluded from our terms of reference. There probably are real problems of efficiency in this field, but they are, nevertheless, different from those in large new road schemes in a number of fundamental respects: problems of land acquisition seldom arise; and the base-load is carried by local authorities' direct labour forces, so that design and execution are not separated in the way that raises problems of efficiency in major road construction schemes. Some of us have direct and current experience of maintenance and minor improvement works programmes, but most of us have not, and we consider that if a study of efficiency in road maintenance and minor improvements is needed, it should be remitted to another team whose membership is specifically suited to the subject matter.

Review of our remit

5.4 One of our main tasks was to examine trends of road-construction costs and prices, and the reasons for them, and having considered methods of measuring productivity in road construction, to select the most appropriate and to examine the trends of productivity. The cost survey we commissioned gave better general information about the trends of road-construction costs than was available before, and enabled us, in chapter 7 of our first report to put forward some explanations of these trends. Nevertheless, as chapter 4 of this report shows, our success in this field has been limited, mainly because the subject matter is so complex and intractable. We have therefore not succeeded in establishing to our own satisfaction any aggregated measure of productivity in road construction and indeed, we have formed the view that to establish such a measure would be an onerous undertaking, and that the results would have relatively little validity or usefulness. However, we have reached definite conclusions, which we set out in that chapter, on the most economical and effective methods of monitoring road construction costs, and of establishing productivity trends satisfactorily. We do not think ourselves fitted to apply these methods, which is rather a task for those who must produce the data and who must use the results. Accordingly we can do no more than to commend them to the Ministry of Transport and to the industry.

5.5 Our second main task was to consider action to increase productivity and reduce costs. This task has proved more appropriate to a body such as ourselves, and we have been able to submit to the Economic Development Committee forty-one conclusions and recommendations in our first report, and another nineteen in this one. We have gone out to the industry to look for suggestions on the development of its practice, and have studied all that have come to us. We think it is unlikely that there are any of significance for the present time which have gone overlooked and unexamined, though, no doubt, as the industry develops and as circumstances change, there will be new opportunities, new problems and new ideas for meeting them. For the time being however, we think there is no more that we can usefully contribute. We have also submitted to the EDC two ancillary reports on the relevance of our studies to other sectors.

5.6 All in all then we consider that we have now done what we can; that we would be wrong to extend our enquiries to fields which we ourselves are not fitted to study and that the fields we are fitted to study have been exhausted. Accordingly, although it was left open when we were set up whether our task was a continuing one, or whether there should be a definite term to our work, it is now our view that we have served our purpose and that our existence as a working party should not be prolonged.

6 Summary of conclusions and recommendations

In our first report we reached forty-one conclusions and recommendations. We have now reached another nineteen, which are listed below.

42 The Lord Chancellor's department should review the possibility of more rapid progress in extending the compulsory registration of land (1.12).

43 The Ministry of Transport should review the rule which requires the district valuer to confirm all settlements reached by county valuers for land purchased for classified roads (1.13).

44 The Ministry of Transport and other government departments should see if the rules can be modified which prevent the payment of prices higher than the market price to landowners as a condition of quick settlement (1.14).

45 The Institution of Civil Engineers should give renewed consideration to the simplification of the system of assessing and certifying interim payments (1.15).

46 We do not advocate any general extension of functional contracting (2.5).

47 We do not see much scope for direct labour on the largest road schemes (2.6).

48 Plant manufacturers and plant users should look together for opportunities to increase the manufacture in this country of specialised road-construction plant (2.7).

49 As the road-construction industry and the plant-hire industry develop, fuller plant utilisation should follow by natural evolution (2.8).

50 The appointed contractors should be required to submit a critical-path network for works of any complexity soon after he is appointed (2.9).

51 Our general conclusion, therefore, on new forms of contract is that it is only for target-price contracts that definite advantages can be claimed and for these only in those exceptional cases where unforeseen circumstances are unlikely to arise.

52 We make no recommendation on the question whether the road programme should be administered by a financially independent roads board (2.11).

53 In managing the execution of the road programme, the Ministry should recognise the economies that accrue from delegated responsibility and flexible administration, as well as the safeguards provided by central control (2.13).

54 The Ministry of Transport should give the results of their labour returns a wide circulation, in order that the other sides of the industry can see the relative magnitude and priority of labour problems in road construction (3.2).

55 Any steps the government, the industry or the professions can take to make possible the movement of middle and senior management from one side of the industry to the other would promote efficiency in road construction (3.6).

56 The availability of manpower would not be a practical limitation on the acceleration of the road programme to any pace that is likely to be decided upon, provided the load on the rest of the construction industry was not also added to, and that the change of pace were not completely unheralded (3.8).

57 A large programme of data collection would not be justified solely for the measurement of average costs and aggregated productivity in road construction (4.10).

58 The Road Research Laboratory should continue, develop and extend its production-studies as quickly as its own resources and the contractors' response permits, and we recommend contractors, in their own and general interest, to participate fully (4.14).

59 The Ministry of Transport should study further with all sides of the industry the returns already collected for manpower and plant employed on each contract, and should continue their studies of methods of estimating requirements for material; and then with the collaboration of the industry, should revise systems of data collection so that they are as useful and as economical as they can be (4.16).

60 The Ministry should commission further cost-studies and we recommend contractors to participate in them fully (4.18).

Appendix 1 Comparison between our first report and this report

Reference in first report (paragraph number)	*Subject*	*Reference in this report (paragraph number)*
2.4-2.6; 2.20	Plant	2.7-2.8
2.7-2.12; 2.15	The structure of the road-construction industry and distribution of work	2.1
2.13	Price collusion	2.2
2.17-2.19; (2.3)	Sub-contractors and main contractors	2.4
2.22	Shift-working	—
2.23	Incentive payments for early completion	1.10
3.2-3.9	The specification and construction costs	1.7; 4.11
3.10-3.13	Standardisation	1.7; 1.9
3.14-3.17	Materials	1.9; 4.11
4.2-4.4. 4.11-4.12	Distribution of design work and site-supervision	1.7; 2.13
4.5-4.8	Feedback from construction to design	1.7; 1.10
4.10	Disturbance of property	1.7
4.13	Responsibilities of the engineer to the contract	2.12-2.13
4.14	Interim measurement and payment	1.15
4.15-4.18	Public utilities' works	1.7
5.3 (2.14)	Selective tendering	—
5.5-5.6	Number of tenders	2.3
5.7-5.13	Information provided to tenderers	1.7; 1.9
5.14-5.15	Contractors' suggestions on design	1.10
5.16-5.18	Time in contract procedures	2.9
5.19-5.21	Contractors' claims	1.10
5.22-5.27	Serial contracts	1.7
5.28	Advance appointment of the contractor	1.10

Reference in first report (paragraph number)	*Subject*	*Reference in this report (paragraph) number*
6.1-6.9	Planning and land-acquisition procedures	1.7
6.10-6.11	The use of compulsory purchase powers	—
6.13	Advance payments for land	5.2
6.14-6.15	Premium payments for land	1.14
6.16	Accommodation works	—
6.17	County valuers	1.13
6.18 (4.10)	Collaboration in design and land acquisition	1.7
6.18	Land registration	1.12
6.19	Contractors' access-routes and working-spaces	1.7
6.20-6.21	Forecasts of future schemes in the programme	1.7
7.1-7.3	Road construction prices	—
7.4-7.8	Road construction costs study	4.1-4.8
7.9	Road construction cost trends, overall	—
7.10	Price of labour, plant and materials	1.9
7.12-7.17	Road construction costs, phase by phase	4.9; 1.7; 1.9
—	Functional contracts	2.5
—	Direct labour	2.6
—	Critical-path scheduling	2.9
—	Cost-plus contracts	2.10
—	Target-price contracts	2.10
—	A roads board	2.11
—	Manpower statistics	3.2; 4.15
—	Training	3.4
—	Manning	3.5
—	Professional manpower	3.6
—	Limitations on the size of the road programme	3.7-3.8
—	Productivity measurement	4.10
—	Information on resources used in road-works	4.15
—	Future cost-studies	4.17

Appendix 2 Organisations who submitted memoranda

Name	*Abbreviation*	*References in the text (paragraph numbers)*
Professional institutions		
Institution of Civil Engineers	ICE	1.7; 1.9; 1.10; 1.15; 2.6; 2.10; 2.12; 3.4; 3.8
Institution of Highway Engineers	IHE	1.7; 2.3; 2.6; 2.10; 2.12; 4.15; 4.17
Institution of Municipal Engineers	IMUNE	1.7; 1.9; 1.10; 1.13; 2.2; 2.3; 2.8; 2.11; 2.10; 2.12; 3.4; 3.6; 4.15; 5.1; 5.2
Local authority associations		
County Councils Association	CCA	1.7; 1.9; 1.12; 1.13; 1.15; 2.2; 2.3; 2.6; 2.8; 2.9; 2.10; 2.12; 5.2
Association of County Councils in Scotland	ACCS	1.7; 1.9; 1.10; 1.15; 2.1; 2.3; 2.6; 2.7; 2.9; 2.10; 2.12; 4.15
Association of Municipal Corporations	AMC	1.7; 1.13; 1.15; 2.10; 2.12
Counties of Cities Association (Scotland)	COFCAS	1.7; 1.9; 2.2; 2.6; 2.8; 2.9; 2.10; 3.6; 5.1
Urban District Councils Association	UDCA	1.7; 1.10; 2.13
Professional associations		
Association of Consulting Engineers	ACE	1.7; 1.9; 1.10; 1.15; 2.3; 2.12; 3.4; 4.5; 5.3
County Surveyors' Society	CSS	1.7; 1.9; 1.10; 1.12; 1.13; 1.15; 2.3; 2.6; 2.7; 2.9; 2.10; 2.12; 4.15
Suppliers' federations		
Asphalt & Coated Macadam Association	ACMA	1.7; 1.9; 2.4; 2.5; 2.7; 2.10; 2.12; 4.2
British Granite & Whinstone Federation	BGWF	1.9
Cement & Concrete Association	C&CA	1.7; 1.9; 2.7; 2.8; 4.15
Home-Grown Timber Corporation Ltd	HGTC	1.9
Reinforcement Manufacturers' Association	RMA	1.9
Sand and Gravel Association	SGA	1.7; 1.9; 2.12; 4.15
Roads interests		
Automobile Association	AA	2.11; 5.1; 5.2
British Road Federation	BRF	1.12; 2.11
Royal Automobile Club	RAC	1.7; 2.11
Royal Scottish Automobile Club	RSAC	1.9

Note In addition to the organisations listed, we received observations on our first report from individual members of the EDC, and from Gardiner and Theobald who carried out our cost-study.

Members of the Working Party

Mr J A Lofthouse, MA (*chairman*), Deputy chairman, Heavy Organic Chemicals Division, ICI Ltd

Mr J Armour, MICE, MIMUNE, Master of Works and City Engineer, Glasgow Corporation

Mr J W Baxter, BSC, MICE, G Maunsell and Partners, Consulting Engineers

Mr E U Broadbent, BSC, MICE, Director, John Laing Construction Ltd

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